CLAIMS

1. An injection molding apparatus, comprising:

a manifold, said manifold having an inlet for receiving melt from a melt source, said manifold defining a runner, wherein said runner is downstream from said inlet, and said runner is upstream from a manifold outlet;

a nozzle, said nozzle defining a nozzle melt channel, wherein said nozzle melt channel is downstream from said manifold outlet, wherein said nozzle includes a nozzle body, a nozzle tip, a seal piece, and a heater thermally connected to said nozzle body for heating melt in said nozzle melt channel, said nozzle tip and said seal piece are connected with respect to said nozzle body, wherein said nozzle tip defines a portion of said nozzle melt channel, and wherein the thermal conductivity of said nozzle tip is higher than the thermal conductivity of said nozzle body, and wherein the thermal conductivity of said seal piece is lower than the thermal conductivity of said nozzle body;

a mold block defining a mold cavity, said mold block defining a gate into said mold cavity, wherein said gate is downstream from said nozzle melt channel, wherein said gate includes a gate sealing surface, said mold block having at least one cooling channel therein for conveying a coolant threrethrough for cooling said mold cavity, wherein said mold block and said seal piece engage each other to inhibit melt leakage therebetween,

wherein a chamber is defined between said mold block, said nozzle tip and said seal piece, said chamber being positioned downstream from said nozzle melt passage and upstream from said gate, wherein said nozzle tip has sufficient surface area in said chamber to maintain melt in said chamber in a substantially molten state;

a valve pin, wherein said valve pin is movable into and out of said gate to control melt flow through said gate, wherein said valve pin has a bottom end, said valve pin has a valve pin sealing surface proximate said bottom end, said valve pin sealing surface is engageable with said gate sealing surface to inhibit melt flow into said mold cavity;

a first guidance and alignment structure connected to said valve pin, wherein said first guidance and alignment structure includes a first guide surface and a first alignment surface, wherein said first guide surface has a cross-sectional diameter that decreases gradually in a downstream direction, and wherein said first alignment surface is generally cylindrical and said first guide surface is positioned immediately downstream from said first alignment surface; and

a second guidance and alignment structure connected to said mold block upstream from said gate, wherein said second guidance and alignment structure includes a second guide surface and a second alignment surface, wherein said second guide surface has a diameter that decreases gradually in a downstream direction, and wherein said second alignment surface is generally cylindrical and said second guide surface is positioned immediately upstream from said second alignment surface, wherein said second guide surface is positioned to engage said first guide surface to slide said valve pin into alignment with said gate when said valve pin is misaligned with said gate during movement of said valve pin towards said gate, and wherein said second guide surface is positioned to complete alignment of said valve pin with the gate prior to contact between said valve pin and said gate, wherein said second alignment surface is positioned to engage said first alignment surface to maintain said valve pin in alignment with said gate during movement of said valve pin towards said gate.

2. An injection molding apparatus as claimed in claim 2, wherein said second guidance and alignment structure includes a relief channel that extends along at least a portion of said first guide surface and at least a portion of said first alignment surface.

3. An injection molding apparatus as claimed in claim 2, wherein said second guidance and alignment structure includes a relief channel that extends along at least a portion of said second guide surface and at least a portion of said second alignment surface.

4. An injection molding apparatus as claimed in claim 1, further comprising:

a third guidance and alignment structure connected to said valve pin, wherein said third guidance and alignment structure includes a third guide surface and a third alignment surface, wherein said third guide surface has a cross-sectional diameter that decreases gradually in a downstream direction, and wherein said third alignment surface is generally cylindrical and said third guide surface is positioned immediately downstream from said third alignment surface and is downstream from said third alignment surface; and

a fourth guidance and alignment structure connected to said nozzle tip, wherein said fourth guidance and alignment structure includes a fourth guide surface and a fourth alignment surface, wherein said fourth guide surface has a diameter that decreases gradually in a downstream direction, and wherein said fourth alignment surface is generally cylindrical and said third guide surface is positioned immediately upstream from said fourth alignment surface, wherein said fourth guide surface is positioned to engage said third guide surface to slide said valve pin into alignment with said gate when said valve when said valve pin is misaligned with said gate during movement of said valve pin towards said gate, and wherein said fourth guide surface is positioned to complete alignment of said valve pin prior to contact between said valve pin and said gate, wherein said fourth alignment surface is positioned to engage said third alignment surface to maintain said valve pin in alignment with said gate during movement of said valve pin towards said gate.

5. An injection molding apparatus as claimed in claim 1, wherein said nozzle tip is retained in said nozzle body by said seal piece.

6. An injection molding apparatus as claimed in claim 1, wherein said nozzle tip is connected to said nozzle body by a threaded connection.

7. An injection molding apparatus as claimed in claim 1, wherein said seal piece is a first seal piece, and wherein a second seal piece separates said

first seal piece and said nozzle tip and seals therebetween to provide an airspace between said first seal piece and said nozzle tip.

8. An injection molding apparatus as claimed in claim 1, wherein said first guidance and alignment structure is removably connected to said valve pin.

7. An injection molding apparatus as claimed in claim 1, wherein said second guidance and alignment structure is removably connected to said mold block.

8. An injection molding apparatus as claimed in claim 1, wherein said second guidance and alignment structure is positioned in a gate insert that contains said gate and is removably connected to said mold block.

9. An injection molding apparatus as claimed in claim 1, wherein said first guide surface curves gradually into said first alignment surface.

10. An injection molding apparatus as claimed in claim 1, wherein said second guide surface curves gradually into said second alignment surface.

11. An injection molding apparatus as claimed in claim 1, wherein said gate and said second guidance and alignment structure are defined in a gate insert that connects to both said nozzle body and said mold block.

12. An injection molding apparatus as claimed in claim 1, wherein said manifold has a plurality of said manifold outlets, and has a plurality of said runners downstream from said inlet and upstream from said plurality of manifold outlets, and wherein said injection molding apparatus includes a plurality of said nozzles, wherein each nozzle is downstream from one of said plurality of manifold outlets, wherein said mold block defines a plurality of said mold caviti s and defines a plurality of said gates into said plurality of said mold cavities,. and wherein said mold block and said nozzle tip and said seal piece on each nozzle define one said chamber, and wherein said injection

molding apparatus includes one said valve pin for each gate and one first guidance and alignment structure for each valve pin and one second guidance and alignment structure for each gate.

13. An injection molding apparatus comprising:

a nozzle body having a melt channel, said nozzle body being made of a first material;

a valve pin at least partially positioned in the melt channel, said valve pin having a first guidance and alignment structure thereon;

a nozzle tip connected to the nozzle body;

a seal piece connected to the nozzle body;

a mold gate insert having a gate, said mold gate insert being in contact with the seal piece;

wherein, the nozzle tip is made of a second material having a higher thermal conductivity than said first material,

wherein the seal piece is made of a third material having a lower thermal conductivity than said first material,

wherein the mold gate insert is made of a fourth material having a higher thermal conductivity than said third material,

and wherein the mold gate insert includes a second guidance and alignment structure thereon that contacts the first guidance and alignment structure before the valve pin contact the gate.

14. An injection molding apparatus as claimed in claim 13, wherein the nozzle tip has nozzle tip guidance and alignment structure that contacts the first guidance and alignment during movement of the valve pin towards the gate orifice.

15. An injection molding apparatus as claimed in claim 13, wherein the nozzle tip is threaded to the nozzle body.

16. An injection molding apparatus as claimed in claim 13, wherein the seal piece is threaded to the nozzle body.

17. An injection molding apparatus as claimed in claim 13, wherein the seal piece retains the nozzle tip.

18. An injection molding apparatus as claimed in claim 13, wherein the guiding portion of the valve pin is made of a separate piece.

19. An injection molding apparatus as claimed in claim 13, wherein said gate and said second guidance and alignment structure are defined in a gate insert that connects to both said nozzle body and said mold block.

20. A method of guiding a valve pin for an injection molding apparatus into engagement with a gate of said molding apparatus comprising:

providing a first guide surface on said valve pin adjacent to but upstream from the sealing surface of said pin and a second guide surface on said molding apparatus adjacent to but upstream from said gate;

providing a first alignment surface on said valve pin adjacent to but upstream from the sealing surface of said pin and a second alignment surface on said molding apparatus adjacent to but upstream from said gate; and

guiding said valve pin as said pin moves downstream towards said gate by interaction of said first and second guide surfaces and interaction of said first and second alignment surfaces before said pin closes said gate.